Case study

Double deaths due to domestic carbon monoxide poisoning correlated with medicolegal autopsy and laboratory studies

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ABSTRACT

Carbon monoxide poisoning is one of the most prevalent types of accidental poisoning worldwide, especially in houses and hotels with malfunctioning or badly maintained appliances. Most carbon monoxide poisoning cases remain undetected because of common symptoms of flu and lack of knowledge. Two people died as a result of unintentional carbon monoxide poisoning in the restroom, which we reported. On the next day of Valentine's Day, a boy and a girl, both about 23 years old and healthy students, were discovered dead inside a bathroom in a compromised position. Medicolegal autopsy revealed the Cherry-red discolouration of the skin, mucous membranes, conjunctivae, nail beds, and areas of hypostasis was seen in both the deceased. Further analysis of the crime scene reveals that the bathroom lacks adequate aeration. Suggestive of a carbon monoxide poisoning which was later confirmed in laboratory analysis of post-mortem blood by UV visible spectrophotometry revealed the presence of dangerous levels of carboxyhaemoglobin i.e., 38.27% in male and 36.79% in female. This method of detecting carboxyhaemoglobin in blood is easy and inexpensive. This case serves to increase awareness of fatal carbon monoxide poisoning by gas geysers. Carbon monoxide poisoning is linked to a high death and morbidity rate. Due to the rising usage of gas water heaters in homes, public awareness of the hazards associated with carbon monoxide, with an emphasis on preventive measures at home, is essential for avoidance.

Keywords: Carbon monoxide poisoning; carboxyhaemoglobin; histopathological studies; UV visible spectrophotometry; post mortem samples.

INTRODUCTION

Carbon monoxide (CO) gas is highly toxic to animals where hemoglobin is used as oxygen carrier. Because carbon monoxide is colourless, odourless, and tasteless, it is extremely difficult to detect in the environment (1). Carbon monoxide is also known as the "Silent Killer" since it is responsible for a huge number of fatal poisonings that occur accidentally around the world (2,3). It has an affinity for hemoglobin which is approximately 220 times as that of oxygen. It displaces oxygen from oxyhemoglobin and simultaneously changes the allosteric structure of hemoglobin increasing the affinity of the remaining sites for bound oxygen. As a result, the oxygen carrying capacity of blood is decreased and flow of oxygen to the tissues is inhibited which leads to progressive asphyxia. The heart and brain, which have high metabolic activity, are particularly vulnerable to the cellular hypoxia that results from this process. Carbon monoxide is also a cellular toxin since it competes with oxygen for myoglobin, peroxidase, catalases, and cytochromes. Hence, Carbon monoxide binding to heart muscle myoglobin causes myocardial depression, which is followed by hypotension, which leads to ischemia, aggravating hypoxia caused by reduced oxygen delivery (4). Carbon monoxide gas is becoming increasingly responsible for a high number of deaths and poisonings in the home around the world. Domestic carbon monoxide poisoning, on the other hand, is rarely reported in India and remains an unrecognised problem. The diagnosis of carbon monoxide poisoning is generally based on circumstantial evidence, autopsy findings and estimation of carboxyhaemoglobin in blood. We present here a case of lethal carbon monoxide poisoning caused by an LPG gas water heater put in a bathroom.

The objective of our study was to correlate crime scene findings, autopsy findings, forensic toxicological findings, and histological changes to determine the cause of death in a suspicious death case. Also, to raise awareness about domestic accidental carbon monoxide poisoning by LPG gas geyser.

MATERIALS AND METHODS

Brief history

A boy and a girl, both about 23 years old and healthy students, were found dead inside a bathroom on the next day of Valentine’s Day in 2021. Both the

deceased were said to be in a relationship for quite some time and decided to meet at the boy's residence just before Valentine's Day. The boy's relatives tried calling him on Valentine's Day, but it went unanswered. Then the relatives came near the boy's residence immediately on the same day just to find out that his friends were already present near his house trying to open the main door. After opening the door, and further searching the residence, both the boy and the girl were found dead in the bathroom equipped with gas-geyser, in a compromised position (Fig.1). A case was registered with the Sub-Inspector of Police in the local police station who sent the deceased to KIMS Hospital for Post Mortem examination. A Medico-Legal Autopsy was conducted on the same day and samples were sent to Forensic Science Laboratory and Department of Pathology for necessary examination.

Crime scene examination

The bathroom was 7*4 feet in size, according to the crime scene investigation. The gas geyser was in excellent functioning order. The bathroom's window and door both were in closed condition (Fig. 1). As a result of the bathroom's lack of ventilation, carbon monoxide from the geyser gathered within the room.

Fig. 1: Showing the dead bodies found in the (A) suffocated bathroom (B) equipped with gas-geyser

RESULTS

Medico-legal autopsy findings

External examination

Both the deceased were moderately built and nourished. Rigor mortis was present all over the body with post mortem staining present over the chest in male and over back in female. A cherry-red discolouration of the skin, mucous membranes, conjunctivae, nail beds, and areas of hypostasis was seen in both the deceased, but more distinguishable in the male since he was a light-skinned individual (Fig. 2). A pinkish red froth was present oozing out of the nostrils and mouth of the male. No other external injuries were present on either of the bodies (Fig.3).

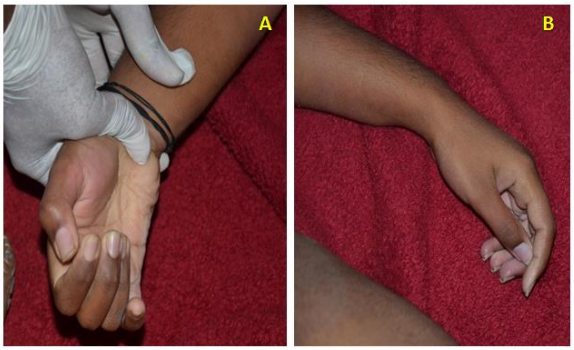

Fig. 2: Showing discoloured nail beds to bluish pink, A-male; B- female.

Fig. 3: Showing cherry-red discolouration of the skin A- areas of hypostasis on male body; B-congested face of female

Internal examination

On gross examination of the internal organs, both lungs showed bright cherry red discolouration which on cut section showed pinkish fluid blood oozing out. Liver, spleen and kidneys also showed bright cherry red colour. On exploration into the skull, meninges & cortex showed haemorrhages and punctiform haemorrhages were seen in the white matter with widespread oedema of the brain. Heart was also bright cherry red colour (Fig-4).

Forensic toxicological analysis

Carboxyhaemoglobin detection by UV spectrophotometric method

The blood and visceral samples were forwarded to the forensic science laboratory for chemical examination. Blood samples for carbon monoxide detection were taken from the deceased heart or main vessels, sealed, labelled with the deceased name, and kept refrigerated. In the laboratory, blood and visceral samples were subjected to detection of any poison and carboxyhaemoglobin.

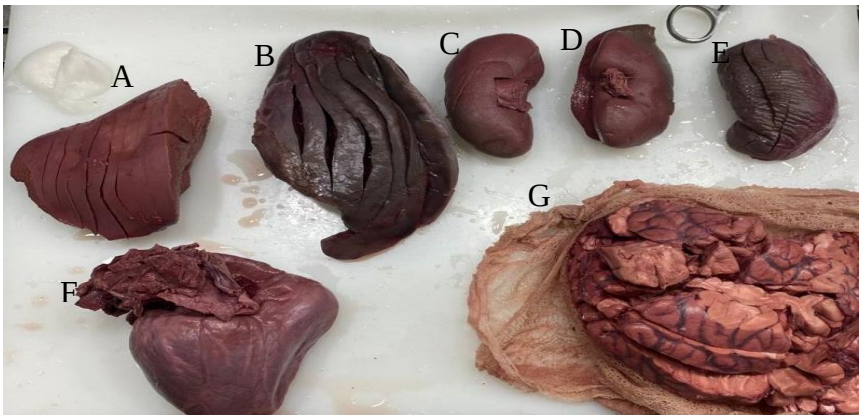

Fig. 4: Internal body organs showing bright reddish discolouration of A-liver, B-Lung, C and D- Kidneys, E-Spleen, F-Heart and G-Brain

Blood samples were subjected for quantitative analysis of COHb by spectrophotometric method. All reagents used were of HPLC grade. A 0.2ml of post-mortem blood sample was added to 20ml of 0.1% ammonium hydroxide and UV absorbance was recorded at 538 and 578nm using Shimadzu UV-1900 with a Quartz cell cuvette of 10nm path length. Then added a pinch of sodium dithionate (reducing agent) again absorbance was recorded at 538nm and 578nm and values were recorded. 0.1% ammonium hydroxide used as a reference standard. Then using the above values, the percentage saturation of carboxyhaemoglobin was determined using the following equation (Fig 5).

$$\%\ saturation\ = \left[\left(2.44 * \frac{\lambda \max @538nm}{\lambda \max @578nm}\right) - 2.68\right] * 100$$

Fig. 5: Equation used for calculating carboxyhaemoglobin

Colour tests and UV-Spectrophotometric methods have responded for the presence of carbon monoxide in all the articles sent, but no other drugs and poison were detected. Percentage saturation of carboxyhaemoglobin in blood sample of – deceased male – 38.27%; deceased female – 36.79% (Fig. 6)

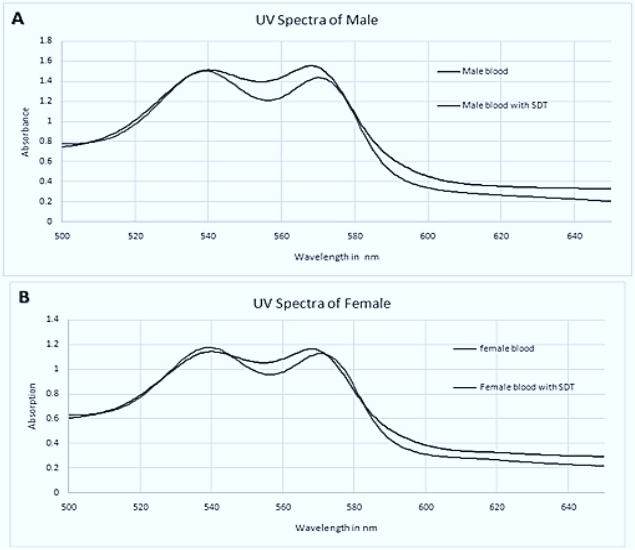

Fig.6: UV-Visible spectrophotometric spectra of male (A) and female blood (B)

Histopathological study of internal organs

Histopathological examination was performed in order to check the view of diffused cherry red discolouration of the organs. The acute carbon monoxide poisoning was co-related with visceral analysis as shown in Fig.7 and Fig.8.

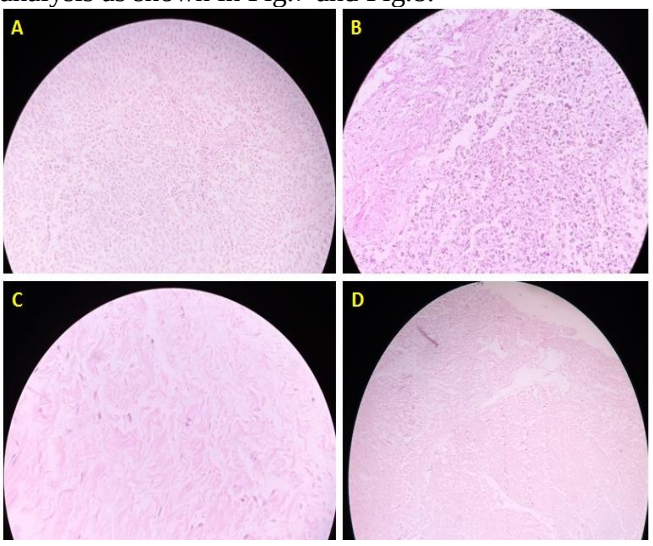

Fig.7: Histopathological analysis showing A-liver; B-Spleen; C-Right ventricle; D-Left ventricle of heart.

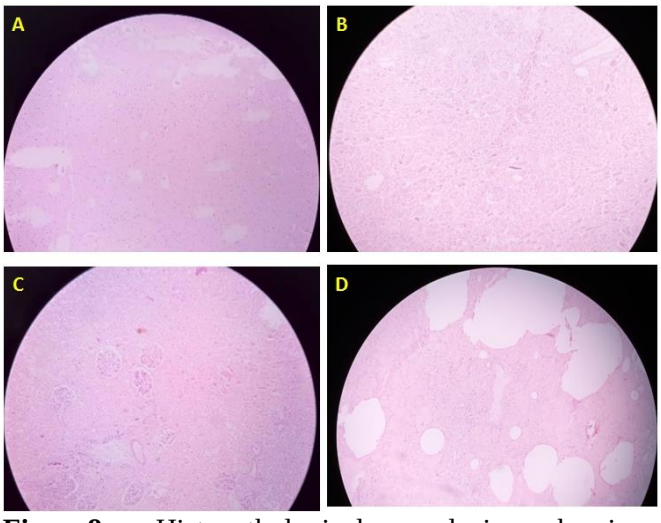

Fig 8: Histopathological analysis showing discoloration in A- Cerebrum; B- Renal cortis; C- Renal pelvis; D- lungs.

Crime scene findings

Further investigations with family members revealed that the LPG-powered gas geyser was recently installed and this scene was visited by a team of Forensic experts and investigating police officers. Bathroom was poorly ventilated and door, window was completely closed when the bodies were discovered(Fig. 1).It signifies that carbon monoxide from the geyser gathered in the bathroom due to a lack of ventilation. Because carbon monoxide has no odour like LPG or any other gas, it went unnoticed by the deceased. They died as a result of inhaling carbon monoxide while staying in a carbon monoxide-rich environment.

DISCUSSION

Carbon monoxide is found to react not very quickly with hemoglobin. Red cells when shaken within an atmosphere of 100% carbon monoxide it will take up to 20 mins to saturate and only about 25% of hemoglobin is found converted to COHb after 5mins. As a result, much of the carbon monoxide inhaled has little time to combine with hemoglobin before reaching other vulnerable organs, where it combines with and disturbs cellular enzymes. A saturation level percentage indicates carbon monoxide poisoning as the principal cause of death, and those values indicate the amount of smoke ingested by a person. Hence, carbon monoxide acts as a major contributing factor and proves beyond doubt that the deceased was alive when the fire started. Clinical chemists generally have the advantage of utilizing fresh blood sample and concentrate on spectrophotometric methods designed to estimate the percentage of hemoglobin where it gets combined with carbon monoxide to produce COHb. These measurements can also be unreliable in the presence of other hemoglobin pigments, and estimations in old or postmortem blood samples are especially difficult in this respect due to the spontaneous production of methemoglobin and sulphemoglobin (6).

The production of carboxy haemoglobin (COHb), which reduces the blood's oxygen carrying capacity, is frequently the deadly effect of high-concentration carbon monoxide exposure(7). Also, the other possible mechanism of toxicity may be due to alteration in dissociation characteristic of oxyHb decreasing oxygen delivery to tissues. By interacting with cytochromes and metalloenzymes, as well as attaching to myoglobin, this causes cardiac and skeletal muscle dysfunction, as well as reduced tissue perfusion(8). The clinical presentation found in carbon monoxide poisoning states to be non-specific and may vary from headache, nausea, dizziness, confusion to profound central nervous system dysfunction and ultimately death. Hence it is very much necessary to estimate levels of carboxyhaemoglobin in emergency department. Less marked differences in histopathology results of organs make the diagnosis difficult, as mentioned in the reported case where the victims have slightly increased carboxy haemoglobin levels and they were healthy individual before this incident happened. Carbon monoxide poisoning is indicated by the cherry pink/red colour of hypostasis in tissues and organs. After prolonged exposure, a cherry red colour appears, which could be due to a combination of carbon monoxide-induced vasodilation and tissue ischemia (9,10).

With all these surveys the incidence of carbon monoxide is responsible for increasing number of accidental domestic poisoning seen commonly with home having faulty or poorly ventilated combustible appliances in kitchen and bathroom. Gas geysers are widely acknowledged as being both cost-effective and simple to use, making them a popular means of water heating, particularly in our country's suburbs. This necessitates vigilance while taking precautions when using a gas water heater unless proper preventive measures are applied. Also elevated index of suspicion is required among the clinicians for its diagnosis in suspected cases as the history of potential exposure also plays major role in carbon monoxide poisoning leading to deaths.

CONCLUSION

Carbon monoxide is an unusual poison and its measurement in blood must be related in an efficient way to find out how it reduces oxygen supply to the tissues. Carbon monoxide poisoning symptoms were indistinguishable from flu symptoms, so it is critical to detect carboxyhemoglobin in blood using a simple, quick, and accurate method which is UV spectrophotometric analysis. Hence, estimating carboxyhaemoglobin levels in the emergency department is critical so that patients can receive proper treatment on time.Immediate medical help should be sought if poisoning symptoms are weak and a high index of suspicion on clinician’s part remains vital. With increasing use of gas water heater, public education about the dangers of carbon monoxide should emphasis on safety measures at home remains the key to effective prevention.

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CONFLICT OF INTEREST

There is no conflict of interest

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